

REVIEW OF THE EPIGEAN SPECIES OF AUSTRALIAN *LIMBODESSUS* GUIGNOT (INSECTA: COLEOPTERA: DYTISCIDAE).

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Summary

WATTS, C. H. S. & LEYS, R. (2005). Review of the epigean species of Australian *Limbodessus* Guignot (Insecta: Coleoptera: Dytiscidae). *Trans. R. Soc. S. Aust.* 129(1), 1-13, 31 May, 2005.

DNA sequencing of the CO1 and 16s-tRNA-NDI fragments of the mitochondrial genome was used to support the morphological results. Nine species are recognised; *Limbodessus amabilis* (Clark), *L. capeensis* sp. nov., *L. compactus* (Clark), *L. gemellus* (Clark), *L. inornatus* (Sharp), *L. occidentalis* (Watts & Humphreys), *L. praelargus* (Lea), *L. shuckardii* (Clark), and *L. rivulus* (Larson). *Limbodessus dispar* (Sharp) is synonymised with *L. shuckardii* (Clark). A key to the species is provided.

KEY WORDS: Coleoptera, Dytiscidae, *Limbodessus*, Taxonomy, DNA.

Introduction

Among the commonest diving beetles in southern Australia are members of the genus *Limbodessus* Guignot of the tribe Bidessini, which are often abundant in still to slightly moving, shallow water. The genus level classification of these beetles has recently been revised by Balke and Ribera (2004), who, based on morphological and DNA sequence data, synonymised the genera *Boongurrus* Larson, *Tjirtudessus* Watts and Humphreys, the Australian members of *Liodesuss* Guignot and *Limbodessus* Guignot, placing them all in *Limbodessus*. Cooper *et al.* (2002) had previously studied DNA sequence data of species in these genera and tentatively come to similar conclusions but made no taxonomic decisions regarding them.

The species level taxonomy of the species formally placed in *Tjirtudessus*, *Boongurrus* and *Limbodessus* has recently been dealt with by Watts and Humphreys (2003), Larson (1994) and Balke and Sato (1995) respectively. No similar revision has been done for the six Australian species previously placed by Watts (1978) in *Liodesuss*. Increased collecting since 1978 has highlighted the great similarity between these species and the consequential difficulties in their identification.

The need for a soundly based taxonomy of these species has become more urgent with the realisation that they are congeneric with the numerous subterranean species, previously placed in *Tjirtudessus*, being discovered in Western and Central Australia (Watts & Humphreys 1999, 2003,

2004). To understand the evolution of these stygobitic species a better understanding of the taxonomy of the epigean members of the genus is needed.

This paper mainly deals with the species level taxonomy of those Australian species of Bidessini previously classified as *Liodesuss* (Watts 1978, 2002). Utilising the extensive collection in the South Australian Museum, it is based on adult morphology, in particular the male genitalia, supported by DNA sequence analysis of the CO1 and 16S-tRNA-NDI fragments of the mitochondrial genome of key specimens. For details of the DNA procedures used see Cooper *et al.* (2002). For completion, brief notes are given on the three other epigean *Limbodessus* species that were previously placed in *Limbodessus* and *Boongurrus* (Watts 2002; Watts and Humphreys 2004).

Unless otherwise noted all specimens were collected by C. H. S. Watts.

Abbreviations

BMNH The Natural History Museum, London.

SAMA South Australian Museum, Adelaide.

TABLE 1. Observed DNA sequence divergence among *Limbodessus* species previously placed in *Liodesuss*.

Comparison	% Sequence divergence
Within the <i>Limbodessus</i> spp. given below.	2.9-10.8
Between sister species:	
<i>L. inornatus</i> (3) - <i>L. gemellus</i> (3)	2.9-3.7
<i>L. amabilis</i> (1) - <i>L. praelargus</i> (1)	3.3
Within species:	
<i>L. gemellus</i> (3)	0.1-0.3
<i>L. shuckardii</i> (1)/ <i>L. dispar</i> (3)	0.0-0.7

(n) = number of sequenced specimens per species.

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Results

The combined morphological and DNA results recognise six species, one of which, *L. capeensis*, is new.

Limbodessus dispar (Sharp) from the Southwest is morphologically indistinguishable from the eastern *L. shuckardii* (Clark). DNA sequence data confirm a close relationship with specimens from Western Australia and Victoria differing at only 0.0% – 0.7% sequence divergence (Table 1). We consider them to be the same species.

Specimens morphologically identified as *L. gemellus* (Clark) (see keys and under species descriptions) from Tasmania (19 km W. Maydeena), Adelaide (Onkaparinga gorge) and the Flinders Ranges (Moro Gorge) are closely similar biochemically (Table 1). These differ by 2.9 – 3.7% sequence divergence from specimens identified as *L. inornatus* (Sharp) from the Southwest. These are morphologically close but differ in the distal shape of the penis. We consider that the sequence and morphological differences are sufficient to consider them separate species. *Limbodessus amabilis* (Clark) and *L. praelargus* (Lea) are morphologically indistinguishable other than by their differently shaped penises. The sequence data confirm their specific separation (Table 1).

Systematics

Diagnosis

The specimens discussed here share the following morphological features.

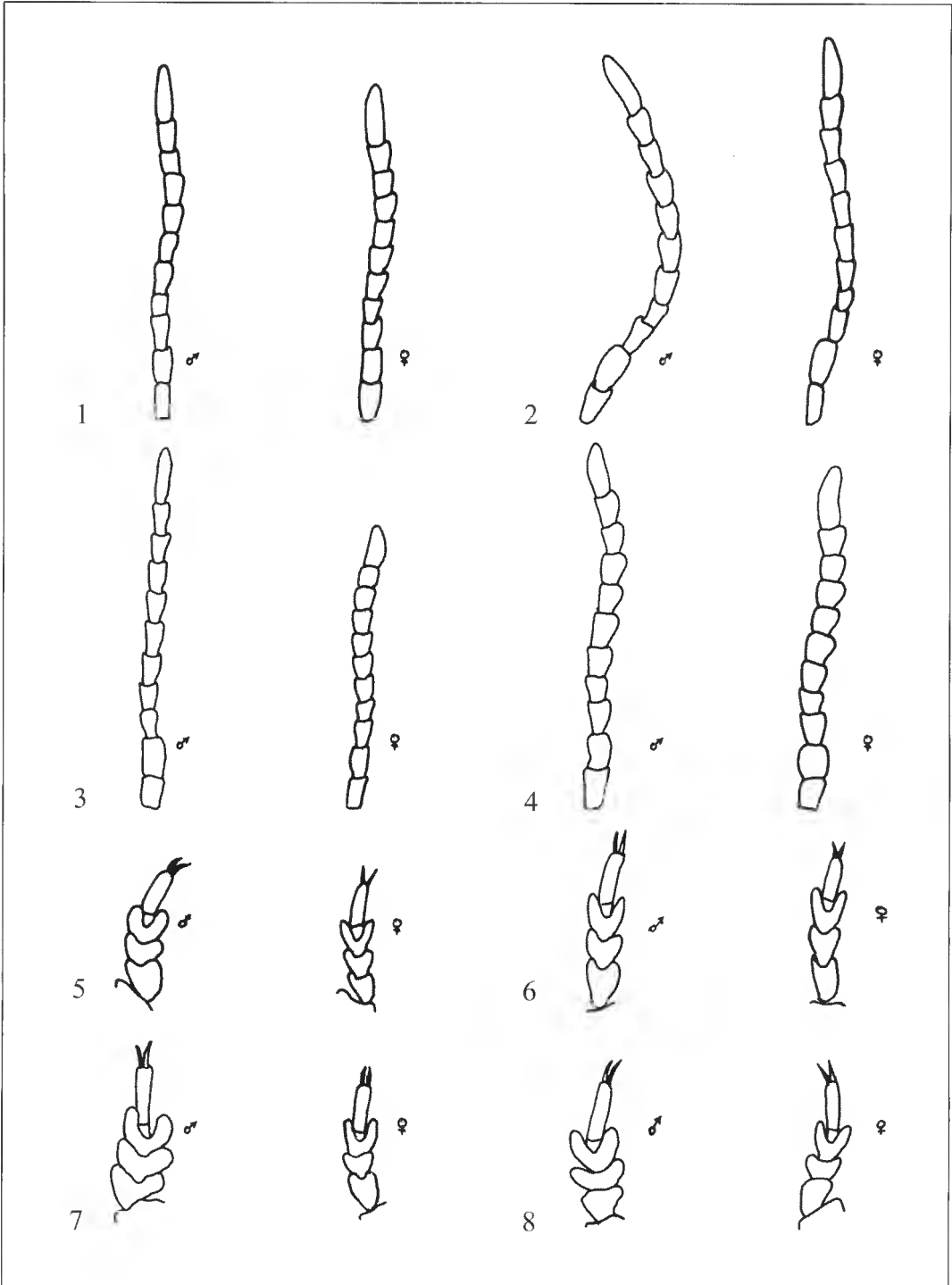
Epigean Australian Bidessini. Elongate-oval, without sutural striae, with well-developed elytral and pronotal plicae, with long metacoxal lines, paramere two segmented, with well-developed finger-like apical lobe on distal segment of paramere (Figs 11-18). (Subterranean species of *Limbodessus* are more varied in shape and may lack the elytral and pronotal plicae and metacoxal lines (Watts and Humphreys 2003).)

Key to epigean species of *Limbodessus*

Including *Allodessus bistrigatus* (Clark) which is closely related (Balke and Ribera 2004) and is often confused with species of *Limbodessus*.

1. Extreme front of elytral epipleuron with raised transverse carina delineating a basal pit.....
.....*Limbodessus compactus* (Clark)
- Elytral epipleuron without basal pit.....2
2. Head with fine line between back edges of eyes (cervical stria).....4
- Head without cervical stria or, if present, only weakly and partially (Pilbara, Yilgarn and Atherton Tableland).....3

3. Eyes of normal size, hind edges reaching well beyond anteriolateral corners of pronotum. Western Australia (Fig. 26).....*L. occidentalis*(Watts & Humphreys)
- Eyes reduced to about 60% normal size, hind edges not, or only just, reaching anteriolateral corners of pronotum. Atherton Tableland (Fig. 28)*L. rivulus* (Larson)
4. Paramere with apical segment simple, finger-like (Fig. 11). Dorsal surface reddish/yellow to greyish, elytra with diffuse darker markings; ventral surface in female with black metathorax and metacoxae and yellow abdomen, males black except prosternum and head; segments of female antenna with a basal groove; elytra densely but relatively weakly punctate, coxal plates moderately punctate
.....*Allodessus bistrigatus* (Clark)
- Paramere with apical segment strongly lobed, often hook-like (Figs 13-20). Segments of female antennae without basal groove; ventral surface usually more uniformly coloured; punctures variable 5
5. Metacoxal plates with numerous large punctures; (Northeast Queensland, Fig. 22)
.....*L. capeensis* sp. nov.
- Metacoxal plates virtually impunctate6
6. Pronotal plicae straight; never with dorsal surface mat; antenna relatively thin (Fig. 1); pro and mesotarsi in males moderately expanded (Fig. 5); paramere with apical lobe without setae (Fig. 13). Southeast7
- Pronotal plicae slanted or curved inwards; may have mat dorsal surface; antenna, particularly in females, stout (Figs 3, 4); pro and mesotarsi strongly expanded, particularly in the males (Figs 7, 8); paramere with apical lobe with long setae (Fig. 20). Southeast and Southwest.....8
7. Penis with apical quarter relatively broad, noticeably narrowing only close to tip (Fig. 13)..
.....*L. amabilis* (Clark)
- Penis with apical quarter narrowing to blunt point (Fig. 18)*L. praelargus* (Lea)
8. Penis suddenly narrowing to narrow apical quarter (Fig. 20); length 2.5 – 3.0 mm; pronotum with disc usually diffusely darker; elytron with colour pattern tending linear; pronotal plicae tend to curve inwards in apical half; antenna, particularly in female, stout (Fig. 4)
.....*L. shuckardii* (Clark)
- Penis evenly narrowing to tip in apical quarter (Figs 15, 16); length 2.2 – 2.8 mm; pronotum never with disc diffusely darker; elytron with colour pattern blotchy; pronotal plicae sinuate; antennae not as stout (Fig. 3).....9
9. Penis with apical portion long and thin, parallel sided (Fig. 15); protibiae in female moderately



Figs 1-4. Male and female antennae of: 1, *Limbodesmus amabilis*; 2, *L. capeensis*; 3, *L. inornatus*; 4, *L. shuckardii*.
 Figs 5-8. Male and female protarsi of: 5, *Limbodesmus amabilis*; 6, *L. capeensis*; 7, *L. inornatus*; 8, *L. shuckardii*.

- broad (Fig. 10); Southeast (Fig. 24).....
*L. gemellus* (Clark)
 – Penis with apical portion smoothly narrowing to tip (Fig. 16); protibiae in female very broad (Fig. 9); Southwest (Fig. 25).....*L. inornatus* (Sharp)

Descriptions.

(In alphabetical order.)

Limbodessus amabilis (Clark)

Hydroporus amabilis Clark, 1862, p. 420.

Liodessus amabilis (Clark). Guignot, 1939, p. 54.

Limbodessus amabilis (Clark).

Balke and Ribera, 2004.

Types

Lectotype (designated by Watts 1978). Upper specimen of two mounted on separate cards on same pin, “amabilis Clark” (yellow label), no data, BMNH.

Paralectotypes 1, pinned under lectotype, “amabilis Clark” (yellow label); 3 females, 1 male mounted on same card, “67.56/ amabilis Clark”; 5, “S. Australia” “Bakewell 59.24”. All BMNH.

Description (number of dissected males examined, 27). Figs 1, 5, 13, 21.

Habitus. Length 2.6 – 3.3 mm; moderately convex; not constricted at junction of pronotum/elytra; narrowly oval.

Head. Dark reddish, often lighter towards front. Narrower than elytra. Smooth, shiny, punctures small but deep, rather sparse, stronger and denser towards the rear; cervical stria well marked. Antenna with segment 1 cylindrical, segment 2 as long as segment 1, barrel-shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segment 4 shorter than segment 3, segments 5-10 subequal, segment 11 about twice length of segment 10, narrower (Fig. 1). Maxillary palpus elongate, segment 4 as long as segments 1-3 combined.

Pronotum. Reddish-yellow, diffusely darker towards rear in some. A little narrower than elytra; anteriolateral angles projecting strongly forward; base not constricted, posteriolateral angles square, surface shiny, punctures relatively sparse, uneven in size, small on disc, larger behind, particularly inwards from plicae; basal plicae strong, excavated somewhat on inside, straight, reaching about half way to front margin of pronotum.

Elytra. Dark reddish, most specimens with indistinct light/dark pattern, occasionally distinct. Elongate, widest at middle; shiny, moderately densely and somewhat unevenly covered with moderate punctures; plicae well impressed, straight, about as long as pronotal plicae. Elytron with well developed inner ridge near apex (ligula). Epipleuron

lacking basal carina, relatively broad in anterior quarter, then progressively narrowing to ncar apex.

Ventral surface. Meso and metathorax, metacoxae and abdomen reddish-brown to black, appendages, pronotum and head lighter. Prosternal process narrow between coxae, reaching mesothorax, apical half relatively broad with parallel raised ridges on each side, not arched in lateral view. Metathorax with wings short, broadly rounded in midline behind, with scattered very small punctures. Metacoxal plates large, shiny; punctures very small, scattered; metacoxal lines raised, distinct, moderately widely spaced, reaching to metasternum, weakly diverging; closely adpressed to ventrite I. Ventrites 1 and 2 fused, with a few very large deep punctures, sutural line distinct, ventrites 3 to 5 mobile, with a few small punctures, somewhat denser and larger on ventrite 5.

Legs. Protibia triangular, outer edge straight or weakly bow-shaped, widest at apex where it is about four times its basal width; protarsus weakly expanded, segment 1 about 2x as long as broad, segment 2 a little wider than segment 1, about half as long, segment 3 about as long as segment 1 and same width, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, a bit longer than segment 3, segments 1 to 3 with dense covering of adhesive setae (Fig. 5); claws short and simple. Mesotrochanter elongate, subrectangular, with a row of relatively long thin setae on inner edge; mesofemur with 2 to 3 moderately strong setae near base on hind margin, stronger than those on mesotrochanter, mesotarsus slightly longer than protarsus. Metatrochanter tip rounded; metafemur elongate, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus relatively stout, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

Male.

Little external difference between the sexes except that antennae in the female are a little stouter (Fig. 1). Median lobe of aedeagus moderately broad, apex rounded (Fig. 13). Paramere quite broad, apical segment with apical lobe overlapping apex of rest of segment which is broadly rounded (Fig. 13).

Remarks

A common species in South Australia, Victoria and Tasmania, often occurring together with *L. gemellus*, *L. shuckardii* or *L. praelargus*. Indistinguishable from *L. praelargus* other than by the broad tip to the penis, it is separable from the other two species by its relatively unexpanded pro and mesotarsi and straight rather than curved or sinuate pronotal plicae. Never with a mat female form such as occurs in *L. shuckardii* and *L. gemellus*.

The lectotype is a female and hence, on present knowledge, cannot be separated from *L. praelargus*. Among the paralectotypes is an immature male. The teneral penis appears more like that of *L. praelargus* than *L. amabilis* (M. Balke pers. com.) suggesting that some of the paralectotypes are in fact *L. praelargus*. We have however retained the usage of Watts 1978 and associated the name *L. amabilis* with this species.

Specimens examined (localities of males with genitalia extracted).

New South Wales. Berry 1/68; 14 km W Delegate, 4/11/97. **Victoria.** Buangor, 9/11/97; 1 km S Drik Drik 11/10/97; Mt Emu Creek, 1/59; 3 km S Fisherman's Rest, 6/11/97. **South Australia.** Adelaide, 11/60; Hindmarsh Island, 8/62; Chain of Ponds, 12/62; 3 km W Yunti, 5/10/95; Mt Compass, 8/61; 10 km E Mt Compass, 10/9/97; 1 km S Nangwarry, 5/10/00; Williamstown, 10/61. **Tasmania.** 25 km E Bridport, 23/1/00; 5 km E Bridport, 23/1/00; Cradle Valley Cradle Mountain-Lake St Clair NP, 19/1/00; Ellendale, 1/12/00, 2 km SW Ellendale, 2/12/00; 2 km W Fingal, 23/1/00; Swansea Jan; Haartz Mt, 15 km W Geeveston, 3/12/00; Marcus River, 14 km SW Montagu, 22/1/00; Hobart, Jan; 12 km N Hobart, 2/12/00; 8 km N Kingston, 3/12/00.

Limbodessus capeensis sp. nov

Types

Holotype

Male. "Mellwraith Rng Weather Stn N. Qld 23/7/82. C.Watts." SAMA, SAMA Data Base # 25-002891.

Paratypes

4, as for holotype, SAMA, SAMA Data base # 25-009337; 4, "Captain Billy Ck N.Q. 10/83 C. Watts.", SAMA, SAMA Data base # 25- 009338.

Description (number examined 9). Figs 2, 6, 14, 22.

Habitus. Length 1.9–2.1 mm; moderately convex; very weakly constricted at junction of pronotum/elytra; narrowly oval.

Head. Reddish-yellow. Narrower than elytra. Smooth, shiny, punctures small but deep, rather sparse; cervical stria well marked. Antenna with segment 1 cylindrical, segment 2 as long as segment 1, barrel shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4-10 becoming progressively slightly broader, segment 11 about twice length of segment 10, narrower (Fig. 2). Maxillary palpus elongate, segment 4 as long as segments 1-3 combined.

Pronotum. Reddish-yellow. A little narrower than elytra; anteriolateral angles projecting strongly

forward; base very weakly constricted, posteriolateral angles square, surface shiny, punctures relatively sparse, uneven in size, small on disc, larger behind, particularly inwards from plicae; basal plicae strong, excavated somewhat on inside, sinuate, nearly reaching front margin of pronotum.

Elytra. Rather uniformly dark reddish with tips lighter, some specimens with indistinct light/dark pattern. Elongate, widest behind middle; shiny, quite densely and evenly covered with strong punctures; plicae well impressed, straight, sloping inwards a little, about as long as pronotal plicae. Elytron with well developed inner ridge near apex (ligula). Epipleuron lacking basal carina, relatively broad in anterior quarter, then progressively narrowing to near apex.

Ventral surface. Meso and metathorax, metacoxae and abdomen reddish-brown, appendages, pronotum and head lighter. Prosternal process narrow between coxae, reaching mesothorax, apical half relatively broad with parallel raised ridges on each side, not arched in lateral view. Metathorax with wings short, broadly truncated in midline behind, with large deep punctures. Metacoxal plates large, shiny; punctures moderately dense, large, deep; metacoxal lines raised, distinct, moderately widely spaced, reaching to metasternum, weakly diverging; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, with moderate number of very large deep punctures, sutural line distinct, ventrites 3 to 5 mobile, sparsely covered with small punctures, somewhat denser and larger on ventrite 5.

Legs. Protibia triangular, outer edge weakly bow-shaped, widest at apex where it is about four times its basal width; protarsus very weakly expanded, segment 1 about 2x as long as broad, segment 2 a little wider than segment 1 and a little shorter, segment 3 as long as segment 1 and a little broader, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about same length as segment 3, segments 1 to 3 with dense covering of adhesive setae (Fig. 6); claws short and simple. Mesotrochanter elongate, subrectangular, with a few relatively long thin setae on inner edge; mesofemur with 2 to 3 moderately strong setae near base on hind edge, much stronger than those on mesotrochanter, mesotarsus slightly longer than protarsus. Metatrochanter tip rounded; metafemur elongate, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus relatively stout, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

Male

Little external difference between the sexes. Median lobe of aedeagus moderately broad in

middle, narrowing in apical quarter to blunt point (Fig. 14). Paramere elongate, apical segment with stout apical lobe well separated from rest of segment (Fig. 14).

Remarks

Very similar to some Australian *Leiodytes* in size, colour and strong punctation. Differs from *Leiodytes* in the lack of a slightly raised margin to the front of the head and in the lobed parameres. The small size, unexpanded pro and mesotarsi and very strong ventral punctures readily separate this species from all other Australian *Liodes*. The apical lobe of the paramere is less well developed than in other Australian species. Known only from Cape York.

Etymology

From its locality – Cape York.

Limbodessus compactus (Clark)

Hydroporus compactus Clark, 1852, p. 421.

Bidessus compactus (Clark). Sharp, 1882, p. 362.

Limbodessus compactus (Clark).

Guignot, 1939, p. 53.

= *Bidessus neoguineensis* Regimbart.

Balke & Sato, 1995, p. 188.

= *Uvarus tokarensis* Sato.

Balke & Sato, 1995, p. 188.

Limbodessus compactus is the type species of the genus. It has recently been comprehensively dealt with by Balke and Sato (1995) and because of this is not redescribed here.

Diagnosis

1.6 – 2.5 mm long, boat-shaped, stout antennae, shiny, uniformly reddish, relatively convex, with cervical stria, with basal carina on elytral epipleuron, male genitalia as in Fig. 12.

Remarks

The species is widely distributed in Japan, SE Asia, New Guinea and Australia (Balke & Sato 1995) (Fig. 23). It is readily separated from other *Limbodessus* species by its uniform reddish colour, boat-like shape and the presence of transverse carina at the base of the elytral epipleura. Within Australia it is widespread (see below), favouring the littoral zone of still water. In pools in sandy riverbeds in inland Australia the species has been collected interstitially for a short distance beyond the edge of freestanding water. *Limbodessus occidentalis* and *L. rivulus* occur in similar places but penetrate further interstitially than *L. compactus*.

Specimens examined

New South Wales. 1, Armidale, 1/61; 1, ditto,

21/3/63; 1, Barrington, 17/8/97; 25, 2 km N Batemans Bay, 2/11/97; 2, Berry, 1/63; 5, Collector, 2/61; 2, 2 km N Collector, 26/11/98; 10, 8 km N Failford, 18/8/97; 3, Maclean, 1/61; 3, Nyngan, 16/3/63; Smith's Lake, 5/70. **Northern Territory.** 1, 1 km SE Batchelor, 12/4/66, N McFarland; 2, Cahills crossing, Kakadu National Park, 9/6/73, Upton & Feehan; 25, Cannon Hill Kakadu National Park, 10/10/98; 1, 10 mi E Daly River, 26/6/72, BK Head; 3, Darwin, 13/5/63; 1, Gubara, Kakadu National Park, 12/10/98; 1, Howard Springs, 23/3/98; 2, Jabiru, 12/10/98; 3, Mt Borradaile, 8/10/98; 1, 4 mi W Timber Creek, 14/4/66, N McFarland. **Queensland.** 1, Alligator River, 20 km S Townsville, 25/3/96; 1, 8 km N Bluewater, 3/11/95; 1, Brisbane, 1/61; 17, Bushland Beech, 20 km N Townsville, 26/2/98, AJ. Watts; 3, ditto, 15/3/98; 1, ditto 16/1/98; 4, ditto, 6/2/98; 4, Caloundra, 27/3/63; 5, ditto, 7/3/63; 1, Cairns, 16/4/63; 1, Greenvale, 27/3/96; 2, 70 km SW Greenvale, 28/3/98, AJ Watts; 1, ditto, 11/3/96; 2, Mackay, 4/4/63; 2, Malanda, 13/4/63; 1, 5 km NW Mt Molloy, 5/2/97; 4, Nardello's Lagoon, 29/3/96; 2, Stanthorpe, 1/61; 2, 25 km S Townsville, 25/3/96; 4, 37 km S Townsville, 6/11/95; 1, Townsville, 31/10/95. **South Australia.** 1, Naracoorte, 9/3/71; 1, 25 km NE Mt Gambier, 26/3/82, FA. Forrest. **Tasmania.** 4, 6 km N Pioneer, 13/1/00. **Victoria.** 2, Dartmoor, 12/61; 7, Fern Tree Gully, 12/61; 6, Hcalesville, 12/68; 1, 12 km SW Orbost, 30/11/98; 1, 12 km SW Orbost, 5/11/97; 1, Stratford 7/11/97. **Western Australia.** 2, Cane River HS (old), 22/5/01; 1, Cane River, 22/5/01; 1, 12 km S Newman, 27/5/01; 4, 1 km N Red Hill stn., 22/5/01; 3, 30 km N Red Hill stn., 22/5/01; 8, Wittenoom Gorge, 26/5/01.

Limbodessus gemellus (Clark)

Hydroporus gemellus Clark, 1862, p. 421.

Bidessus gemellus (Clark). Sharp, 1882, p. 362.

Limbodessus gemellus (Clark). Watts, 1978, p. 49.

= *Bidessus mundus* Sharp, 1882, p. 362.

Watts, 1978, p. 49.

Limbodessus gemellus (Clark).

Balke and Ribera 2004.

Types

Bidessus gemellus Clark.

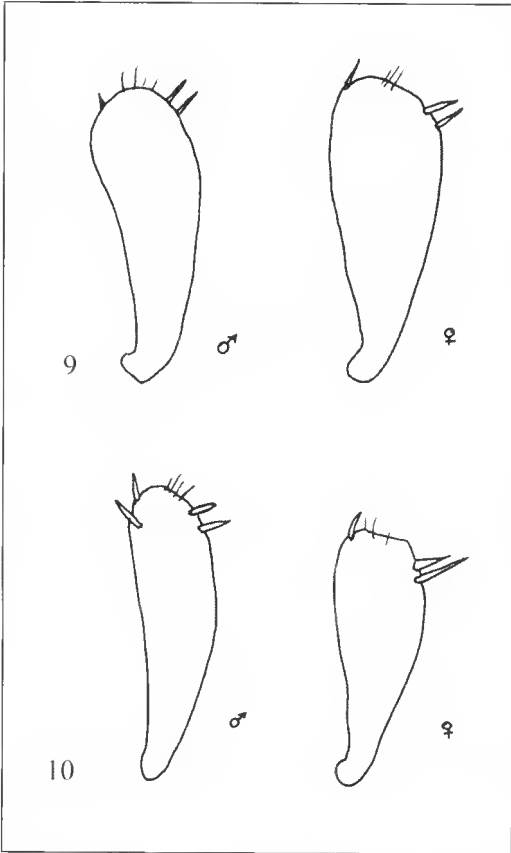
Lectotype "gemellus Clark Australia" (yellow label), BMNH.

Paralectotypes. 2, "gemellus Clark" (yellow label), BMNH.

Bidessus mundus Sharp.

Lectotype. "Type 88/Australia / n.sp. australia / Bidessus mundus/ (male symbol)", BMNH.

Paralectotypes. 1, "Type 88/australia"; 1, "88 / Australia"; both BMNH.



Figs 9-10. Male and female protibia of: 9, *Limbodessus inornatus*; 10, *L. shuckardii*.

Description (number examined, 125.) Figs 15, 24.

As for *L. amabilis* except as follows.

Habitus. Length 2.5 – 3.0 mm; weakly constricted at junction of pronotum and elytra.

Head. Reddish/yellow, darker towards rear.

Pronotum. Reddish-yellow, diffusely darker along front boarder; basal plicae strong, excavated somewhat on inside, curving inwards slightly, straightening towards front.

Elytra. Elongate, widest at middle; moderately densely and evenly covered with moderate punctures; plica well impressed, straight, slanting inwards slightly, about as long as pronotal plicae.

Legs. Protibia bow-shaped, widest near apex where it is about four times its basal width, protarsus moderately expanded (cf. Fig. 7).

Male

Dorsal surface shiny; antennae, tarsi and protibiae relatively stout (cf. Figs 3, 7, 9). Median lobe of

acdeagus broad at base, narrowing to long, thin, apical portion (Fig. 15). Paramere broad, apical segment weakly triangular, apical lobe large, overlapping rest of apical segment at base, with fine setae (Fig. 15).

Female

Dorsal surface duller, often with weak to moderate reticulation. Antennae a little stouter. Protibia wider and more triangular (cf. Fig. 9); pro and mesotarsi slightly less expanded (cf. Fig. 7).

Remarks

Similar in size to *L. amabilis* and *L. praelargus* but more uniformly coloured, with reticulate females, sinuate pronotal plicae, broad pro and mesotarsi and, in the female, broad pro and mesotibiae and stout antennae. Separable from the slightly smaller *L. shuckardii* by the lack of a darker disc on the pronotum, the pronotal plicae more sinuate, and the absence of vague linear markings on the elytra. *Limbodessus inornatus* from the Southwest is very similar morphologically but differs in having a longer, parallel-sided distal portion to the penis (Fig. 16) and female *L. inornatus* have somewhat broader pro and mesotibiae (Fig. 9). With a more inland distribution than *L. amabilis* and *L. praelargus* but not to the same extent as *L. shuckardii*.

Specimens examined

New South Wales. 3, 2 km N Batemans Bay, 18/4/97; 1, Berry, 1/68; 1, 3 km N Bulli, 27/11/98; 2, 8 km N Failford, 18/8/97; 1, Gosford 1/61; 1, 2 km S Nowra, 27/1/00; 3, 2 km S Nowra, 27/11/98; 1, Quaama, 18/1/97; 2, Ulladulla, 2/1/973; 1, Windsor, Lea; 2, Waterfall, 1/6/82. **Queensland**. 1, Queensland, Blackburn coll. **South Australia**. 1, Adelaide, Griffith coll; 1, Chain of Ponds, 10/11/96; 1, Dalhousie Spr. at light, 6/10/87, J.A.Forrest; 1, Flinders Range, May 59; 1, 10 km N Forreston, 17/9/96; 1, Kuipo 35° 14' S 145° 138' E, 5/10/95; 4, Moro Gorge, Flinders Ranges R. Leys; 13, Mt Gambier, 12/16; 3, Myponga, 9/12/96; 3, 13 km W Meadows 36° 11' S 138° 96' E, 28/9/96; 2, 10 km E Mt Compass, 10/9/97; 1, Mt Lofty, Lea; 2, Myponga, 5/1/88; 3, 1 km S Nangwarry, 9/10/97; 3, Port Lincoln, Blackburn; 3, ditto, 1/82; 1, Wood Point River Murray, 4/11/80, P. Waller. **Tasmania**. 1, 5 km E Bridport, 23/1/00; 1, Cradle Mt N P, Jan; 1, 17 km SW Derwent Bridge, 29/11/00; 3, 18 km N Derwent Bridge, 24/1/00; 1, Ellendale, 1/12/00; 1, 2 km SW Ellendale, 1/12/00; 1, 5 km SE Gormanston, 29/11/00; 1, Hatfield River, 15 km SW, 28/11/00; 3, Hobart, 8/61; 2, Hobart, Griffith; 3, 12 km N Hobart, 2/12/00; 1, King Isl, collector unknown; 1, 8 km W Kingston, 3/12/00; 1, 9 km Maydena, 1/12/00; 11, Narcissus Bay Lake St Clair, 30/11/00; 1, 6 km N Pioneer 23/1/00; 3,

2 km W Port Latta, 27/11/00; 1, St Helens, Jan; 1, Swansea, Jan; 1, 16 km N Waratah, 28/11/00; 1, 9 km N Queenstown on B28 Road, 28/12/00. **Victoria.** 1, Buangor, 9/11/97; 4, Dartmoor, 11/10/97; 2, 17 km SW Derwent Bridge, 29/11/00; 2, Healesville, 12/68; 3, 8 km W Kingston, 3/12/002; 1, Omeo, 6/11/97; 3, 30 km W Portland, 10/10/97; 1, Sardine Ck 30 km, N Orbost, 16/1/97; 4, Stratford, 7/11/97.

***Limbodessus inornatus* (Sharp)**

Bidessus inornatus Sharp, 1882, p. 360.

Liodesus inornatus (Sharp). Watts, 1978, p. 48.

= *Bidessus bififormis* Sharp, 1882, p. 362.

Watts, 1978, p. 48.

Limbodessus inornatus (Sharp).

Balke and Ribera, 2004.

Types

Bidessus inornatus Sharp.

Holotype

Male. "Type 81/West Australia/ *Bidessus inornatus* n. sp.", BMNH.

Bidessus bififormis Sharp

Lectotype. "W. Australia/ type 89 ♂ *Bidessus bififormis* n.sp. K.G.Sound", BMNH.

Paralectotypes. 3, same data as lectotype, BMNH. 3, "W. Australia, Swan River." BMNH. 6, "W. Australia", BMNH.

Description (number examined, 351) Figs 3, 7, 9, 16, 25.

As for *L. gemellus* except as follows.

Male

Median lobe of aedeagus relatively broad, narrowing in apical quarter to blunt tip (Fig. 16). Paramere broad, apical segment rounded at apex, apical lobe long, overlapping rest of segment, with fine setae and some peg-like structures on front edge (Fig. 16).

Female

Pro and mesotibiae expanded (Fig. 9).

Remarks

Restricted to the Southwest where it is sympatric with *L. shuckardii*. Can be separated from this species by its larger size, uniform colour on the pronotum, and the pronotal plicae sinuate rather than curved. Female *L. inornatus* have slightly broader pro and mesotibiae (Fig. 9). The front of the apical lobe of the paramere has several peg-like structures not found in other Australian *Limbodessus* (Fig. 16). Indistinguishable from the eastern *L. gemellus* apart from a stouter distal portion of the penis and the peg-like structures on the parameres.

Specimens examined

Western Australia. 3, Armadale, 3/62, D. Edwards; 3, Bickley Swamp, Rottnest Island, 10/58, D. Edwards; 1, Blackwood River, Nannup, 20/10/96; 1, Bonanup, 17/10/96; 13, Bridgetown, 11/9/31, Darlington; 3, 50 km W along Broke inlet Rd Nr Walpole, 18/9/00; 4, 3 km N Bullsbrook, 16/10/96; 1, Bushy Swamp 15 km WNW Woodanilling, 21/9/00; 16, Byenup Lagoon NR, 21/9/00; 6, Corio Spring Rottnest Island, 10/58, D. Edwards; 4, 5 km W Cowaramup, 22/10/00; 1, 2 km SW Dandalup, 23/9/00; 2, 20 km SE Donnybrook, 18/10/96; 3, 30 km S Dwellingup, 17/10/96; 1, 8 km S Dwellingup, 17/10/96; 1, Ellen Brook NR, 14/9/00; 8, 19 km S Fremantle, 24/10/96; 1, Geraldton 10/31, Darlington; Hay River, collector unknown; 13, Ironstone Gully Falls 13 km SW Donnybrook, 22/10/96; 15, 10 km E Kalamunda, 16/10/96; 7, Kodjup NR, 21/9/00 ; 7, Lake Pleasant View, 17/9/00; 1, Lake Parkeyerring, 15/9/00; 1, Lake Poorginup, 20/9/00; 17, Maidavale, 27/4/90; 11, Margaret River, 10/31, Darlington; 7, 4 km N Mumballup, 23/9/00; 1, Nalyerin Lake, 22/9/00; 13, 4 km S New Norcia, 15/10/96; 15 km NW Pemberton, 17/5/87; 1, 20 km W Pemberton, 20/10/96; 7, Pemberton, 10/31, Darlington; 2, 15 km NE Pemberton, 8/10/96; 69, 6 km S Pinjarra, 23/9/00; 48, 30 km N Perth, 14/10/96; 1, Rottnest Island, 10/31, Darlington; 3, 12 km W Serpentine, 24/10/96; Stirling Range, 10/72; 2, Swan River, Lea; 9, Swan River, 10/57, D. Edwards; 11, 20 km W Strachan, 21/9/00; 1, 1 km S Wagin, 21/9/00; 1, Wilgarup River, 6/58, D. Edwards; 1, 16 km N Woodanilling, 15/9/00; 4, Yallingup, 22/10/96.

***Limbodessus occidentalis* (Watts and Humphreys)**

Boongurrus occidentalis

Watts and Humphreys, 2004.

Limbodessus occidentalis (Watts & Humphreys)

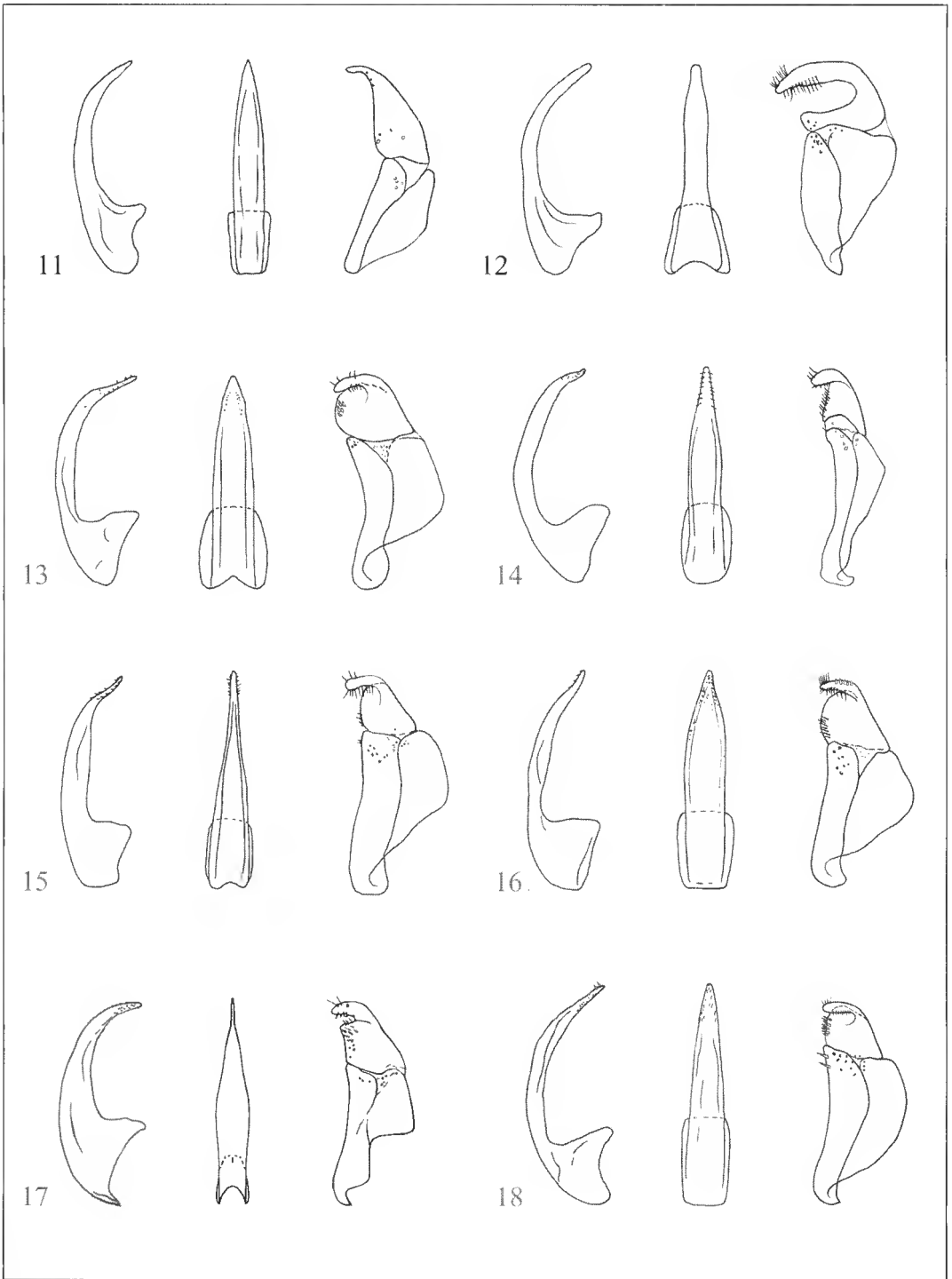
This species has only recently been described (Watts and Humphreys 2004) and hence will not be redescribed here.

Diagnosis

1.9 – 2.3 mm long, relatively flat, elongate-oval, light reddish, elytra darker, without cervical stria, without basal carina on elytral epipleuron, eyes of normal size, male genitalia as in Fig. 17.

Remarks

Limbodessus occidentalis differs from all other epigeal *Limbodessus* except *L. rivulus*, by the absence of a cervical stria between the hind edges of the eye. Like *L. rivulus* it is small (1.9 – 2.3 mm long), flattened with a rugose surface but unlike *L. rivulus* the eyes are not reduced in size. It occurs at the headwaters of sandy/gravelly streams, or at the



Figs 11-18. Dorsal view of penis, lateral view of penis and paramere of: 11, *Allodesmus bistrigatus*; 12, *Limbodesmus compactus*; 13, *L. amabilis*; 14, *L. capeensis*; 15, *L. gemellus*; 16, *L. inornatus*; 17, *L. occidentalis*; 18, *L. praelargus*.

upstream edges of pools in drying riverbeds, in the Pilbara and Yilgarn regions of Western Australia (Fig. 26), often interstitially several meters away from the water's edge. It has also occasionally been taken together with a true stygobitic fauna in shallow calcrete aquifers (Watts and Humphreys 2004).

Specimens examined (Holotype & Paratypes)

Western Australia. 9, 10 km NW Eerala Stn, 23/5/01; 1, Killara Station, 6/6/02, W. F. Humphreys & R. Leys; 3, Moorarie Station, 8/6/02, W. F. Humphreys & R. Leys; 1, Wagga Wagga Station, 4/6/02, W. F. Humphreys & R. Leys; 12, Wittenoom Gorge, Town Pool, 26/5/01, C. H. S. Watts & G. A. Watts.

Limbodessus praelargus (Lea)

Bidessus praelargus Lea, 1898, p. 523.

Liodesus praelargus (Lea). Watts, 1978, p. 51.

Limbodessus praelargus (Lea).

Balke and Ribera, 2004.

Types

Holotype

Male, "praelargus Lea TYPE ♂ Forest Reefs"; dissected and remounted this study, SAMA. SAMA data base # 25-001525.

Paratypes

5 females, same locality; dissected and remounted this study, SAMA. SAMA data base # 25-009153.

Description (number of dissected males examined, 13) Figs 18, 27.

As for *L. amabilis* except:

Male

Medial lobe of aedeagus moderately broad, smoothly narrowing to a blunt point (Fig. 18). Paramere broad, apical lobe stout, overlapping apical portion of apical segment which is relatively narrow and has the apex pointed rather than rounded (Fig. 18).

Remarks

Indistinguishable from *L. amabilis* except for the pointed penis and narrower paramere. The range of the two species is broadly similar. Watts (1978) correctly (but fortuitously) associated the name *praelargus* with the species with the pointed penis. See also under *L. amabilis*.

Specimens examined (localities of males with genitalia extracted.)

Australian Capital Territory. 30 mi S Canberra, 1/61. **New South Wales.** 14 km W Dclagate, 4/11/97.

Victoria. 11 km E Bruthen, 6/11/97; 4 km S Glenista, 24/9/98; 10 km NE Mirranatwa, 12/10/97; 5 km NW Portland, 10/10/97. **South Australia.** Mt Gambier, 12/61; 1 km S Nangwarry, 9/10/97. **Tasmania.** S end of Lake St Clair, 30/11/00; Little Pine Lake, 8 km W Miena, 23/10/00; 2 km W Port Latta, 27/11/00.

Limbodessus rivulus (Larson)

Boongurrus rivulus Larson, 1994.

Limbodessus rivulus (Larson).

Balke and Ribera, 2004.

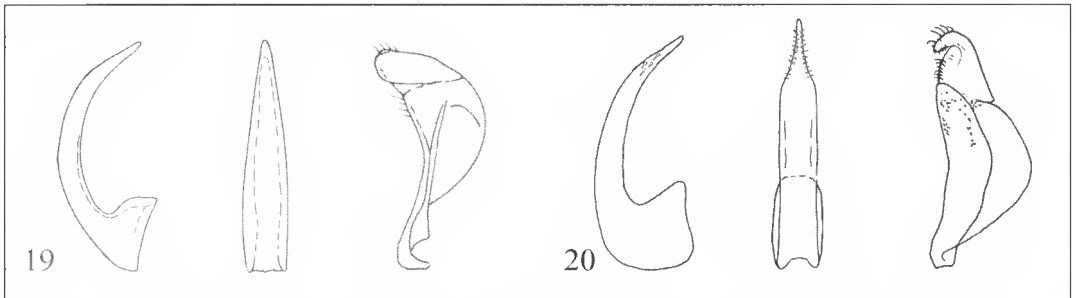
This species has recently been treated in detail (Larson 1994) and hence will not be redescribed here.

Diagnoses

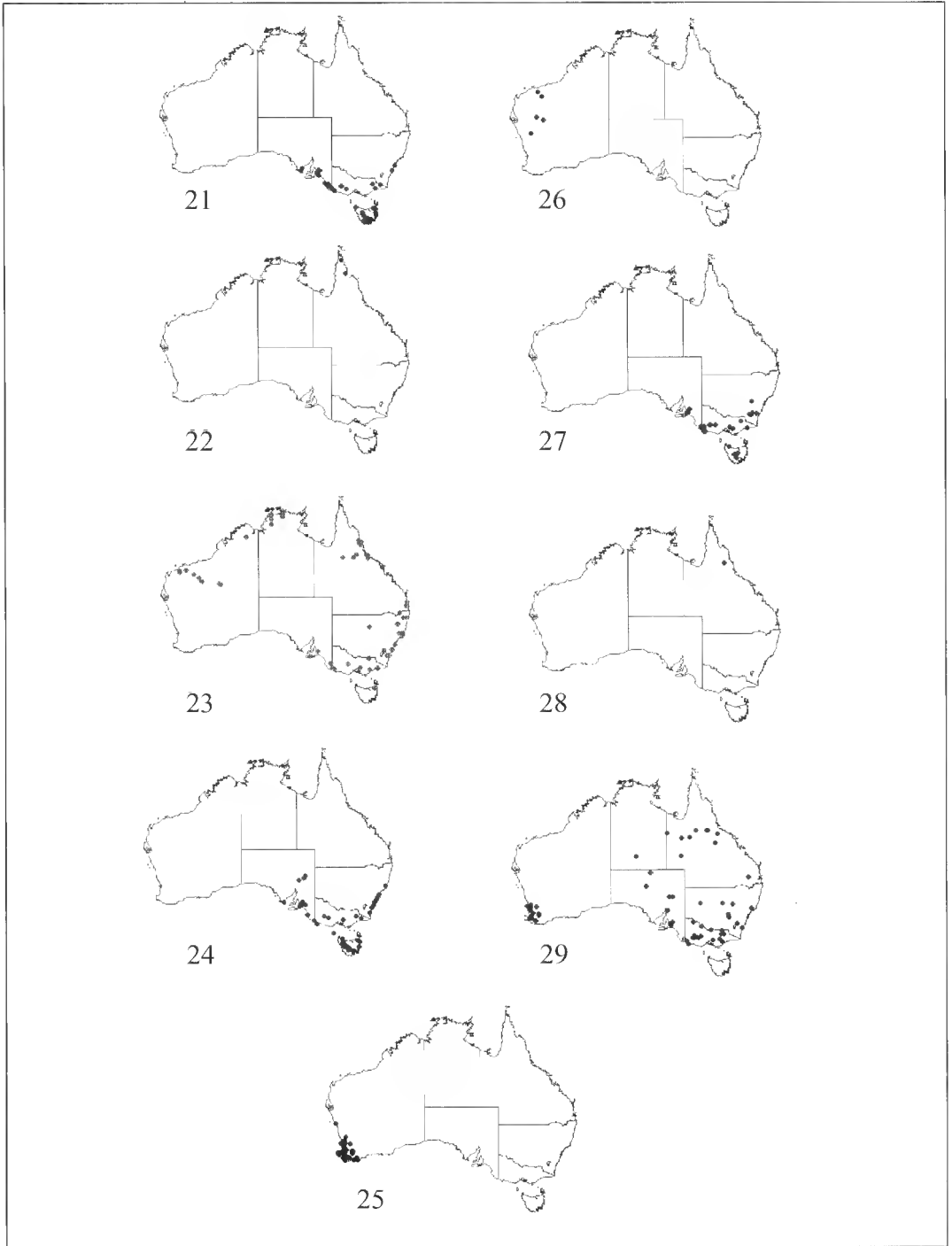
1.8 – 2.2 mm long, rather rectangular, relatively flat, dull reddish with darker areas, strongly reticulate, lacking (or virtually lacking) cervical stria, lacking basal carina on elytral epipleuron, eyes much smaller than normal for epigeic *Limbodessus*, male genitalia as in Fig. 19.

Remarks

Together with *L. occidentalis* the only epigeic *Limbodessus* lacking a cervical stria between the rear of the eyes although Larson (1994) reported its partial presence in a small number of specimens. Separated from *L. occidentalis* by its obviously reduced eyes and characters of the male genitalia (Watts and Humphreys 2004). The species occurs at



Figs 19-20. Dorsal view of penis, lateral view of penis and paramere of: 19, *Limbodessus rivulus*; 20 *L. shuckardii*.



Figs 21-29. Distribution maps of specimens of *Limbodesmus* in the South Australian Museum Entomological collection. 21, *L. amabilis*; 22, *L. capeensis*; 23, *L. compactus*; 24, *L. gemellus*; 25, *L. inornatus*; 26, *L. occidentalis*; 27, *L. praelargus*; 28, *L. rivulus*; 29, *L. shuckardii*.

the headwaters of small, gravely, spring-fed streams in areas of open eucalypt woodland on the Atherton Tablelands. Here it occurs in gravel at the edge of the water or interstitially for at least a metre from the water's edge (pers. observation). Very recently (August, 2004), I have collected a single specimen of this, or a closely related species, from similar habitat on Mt Tamborine in southeast Queensland.

Specimens examined

Queensland. 1, 1 km E Watsonville, 31/3/96; 11, 1.5 km E Watsonville, 3/8/03.

Limbodessus shuckardii (Clark)

Hydroporus shuckardii Clark, 1862, p. 420.

Bidessus shuckardii (Clark). Sharp, 1882, p. 361.

Liodessus shuckardi (Clark). Watts, 1978, p. 47.

Limbodessus shuckardii (Clark).

Balke and Ribera, 2004.

Bidessus dispar Sharp, 1882, p. 363.

Liodessus dispar (Sharp). Watts, 1978, p. 48.

= *Bidessus elegans* Lea, 1898, p. 523. Watts 1978, p. 48.

Limbodessus dispar (Sharp). Balke and Ribera, 2004.

= *Limbodessus shuckardii* (Clark). Syn. nov.

Types

Hydroporus shuckardii Clark

Lectotype. '67.56 /shuckardii Clark australia' (yellow label), BMNH.

Paralectotypes. 1, 'shuckardii (yellow label); 2, 'S. Australia. Bakewell, 59.24; 10, 'australia'; all in BMNH.

Bidessus dispar Sharp.

Lectotype. 'Type 90 ♀ a / Swan River / W. Australia/ W. Australia / Sharp Coll 1905-313 / *Bidessus dispar* Sharp ♀ a Type' (in Balfour-Browne's writing).

Paralectotypes. 2, same locality; 1, 'W. Australia'; both in BMNH.

Bidessus elegans Lea.

Holotype

'*elegans* Lea TYPE Beverley'; left-hand specimen on card marked with TY, SAMA. SAMA data base # 25-001582.

Paratype

Same data as Holotype; right-hand specimen on card, SAMA. SAMA data base # 25-009340.

Description (number examined, 244.) Figs 4, 8, 10, 20, 29.

As for *L. amabilis* except:

Habitus. Length 1.9 – 2.6 mm; very weakly constricted at junction of pronotum and elytra.

Head. Light reddish-yellow with darker patches towards rear. Antenna (male) stout, segment 1 cylindrical, segment 2 as long as segment 1, barrel-shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segment 4 shorter than segment 3, segments 5-10 subequal, slightly wine-glass shaped, segment 11 about twice length of segment 10, narrower (Fig. 4).

Pronotum. Light reddish-yellow with diffuse reddish-brown area on disc. Basal plicae strong, excavated somewhat on inside, curving inwards quite strongly, reaching about two-thirds of way to front margin of pronotum.

Elytra. Light reddish/yellow to reddish yellow with reddish brown pattern, 2-3 thin longitudinal lines partially discernible in most specimens. Elongate, widest at middle; shiny, moderately densely and evenly covered with moderate punctures; plicae well impressed, slanting inwards, about as long as pronotal plicae.

Ventral surface. Light reddish-yellow, meso and metathorax and metacoxae darker. Metathorax with wings short, truncated or broadly rounded in midline behind, virtually impunctate.

Legs. Protibia bow-shaped, widest before apex where it is about 3x its basal width; protarsus moderately expanded, segment 1 a little longer than wide, segment 2 a little wider than segment 1, about half as long, segment 3 about as long as segment 1 and same width, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, a bit longer than segment 3, segments 1 to 3 with dense covering of adhesive setae.

Male

Shiny, antenna and tarsi as above (Figs 4, 8). Median lobe of aedeagus moderately broad, narrowing a little quite abruptly in apical quarter in both dorsal and lateral views (Fig. 20). Paramere moderately broad, apical segment rather small, apical lobe relatively long, overlapping rest of apical segment, with long setae (Fig. 20).

Female

Both dorsal and ventral surfaces weakly to moderately reticulate. Antenna stouter, segments 5-10 almost bead-like (Fig. 4). Pro and mesotarsi broad, but less so than in male (Fig. 8).

Remarks

A relatively small species recognised by the broad pro and mesotarsi, pronotal plicae curving inwards and the centre of the pronotum diffusely slightly darker than the rest. The elytra have indistinct thin

linear markings reminiscent of those of *Hydroglyphus grammopterus* (Zimmerman) which can be faintly seen on most specimens. Other Australian *Limbodessus* can have quite marked linear elytral markings but these are broader and interrupted in the central region. A more inland distribution than other species, present as far north as the Mount Isa – Greenvale region of north Queensland, seemingly absent from Tasmania.

Specimens examined

New South Wales. 1, Collector, 20/1/97; 1, Forbes, 15/3/63; 2, Gilgandra, 19/11/92; 2, Ditto, 9/2/62; 2, Grenfell, collector unknown; 9, Nyngan, 16/3/63. **Queensland.** 11, Camooweal, 30/4/93; 2, Charters Towers, 23/4/63; 1, Cloncurry, 29/4/63; 1, Coorabulka, 7/71; 1, 70 km SW Greenvale, at light, 28/3/95 to 7/4/95, A. J. Watts; 1, ditto, 21-31/10/95; 1, ditto, 29/1/97 to 4/2/97; 1, ditto, 3-10/10/96; 1, Lake Buchanan, 25/9/83, B Timms. **South Australia.** 2, Adelaide; 1, Alligator Gorge, 6/58; 4, Chain of Ponds, 12/62; 1, 20 km N Coober Pedy, 2/68; 2, 10 km N Forreton, 3/9/99; 1, Leigh Creek, Blackburn's coll: 2, 1 km S Nangwarry, 9/10/97. **Victoria.** 1, Albury, 16/7/89, P. Waller; 1, 12 km W Brimpaen, 23/9/98; 5, Buangor, 9/11/97; 1, Dartmoor, 24/9/98; 2, Dodswell Bridge, 10/10/98, D. Churches; 12, Fyans Creek, 15

K S Stawell, 13/1/97; 2, 4 km S Glenista, 24/9/96; 6, Grampians, 2/63; Halls Gap, 13/1/97; 11, Healesville, 12/68; 1, Lake Hattah, Light trap, 28/10/67, G. W. Anderson; 8, 12 km N Mirranatwa, 12/10/97; 2, 10 km NE Mirrantwa, 12/10/97; 1, 5 km NW Portland, 10/10/97; 3, Nathatia, 9/6; 2, Turret Falls, 5 km NW Halls Gap, 13/1/97; 1, Wellington River 4 km N Licola, 30/11/98. **Western Australia.** 2, Armadale, 7/62, D. Edwards; 1, Beverley, Lea; 8, Bridgetown, 9/11/31, Darlington; 1, 5 km N Bushy Swamp nr Wagin, 21/9/00; 2, Byenup Lagoon NR, 21/9/00; 4, 8 km S Dwellingup, 17/10/96; 69, 6 km S Pinjarra, 23/10/96; 2, 8 km N Pinjarra, 23/10/96; 1, Ironstone Gully Falls, 13 km SW Donnybrook, 22/10/96; 4, 10 km S Fremantle, 24/10/96; 1, 4 km N Mumballup, 23/10/96; 1, Nalyerin Lake, 22/9/00; 1, 5 km E Lake Nalyerin, 22/9/00; 1, Riffle Range Swamp, Rottnest Island, 10/59, D. Edwards; 16, 12 km W Serpentine, 24/10/96; 1, 10 km S Yallingup, 22/10/96.

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